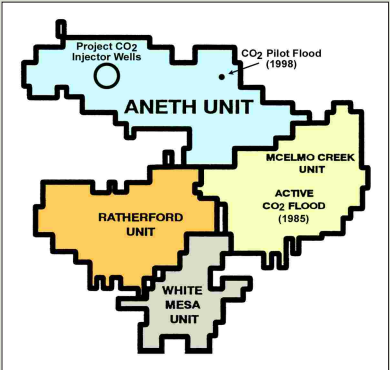## Aneth Unit

- 16,320 acres
- 421 Million Barrels of Oil in Place
- Over 149 Million Barrels Recovered (33% Recovery)
- Waterflood, 1962
- Infill Drilling to 40 acres, 1982; Infilling to 20 acres, 1988

### Units Within Greater Aneth Field

McElmo Creek Unit

- Waterflood, 1962, 4000 BOPD
- Five-Spot Pattern, 80 acre to 40 acre Infills, 1976
- CO_2 Flood (Water Alternating with Gas [WAG]), 1985, Increased Production from 4000 to 7000 BOPD
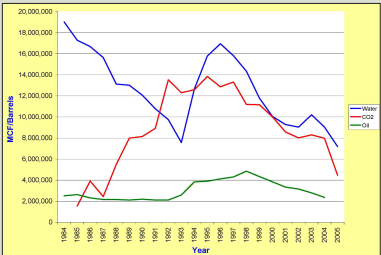- Well Count
    - Oil Producers – 90
    - Water Injectors – 30
    - WAG Injectors – 65
    - Water Supply – 9
    - Shut-In – 49
- Production Declined Since 1998
- CO_2 Cost – $0.40 to $0.85 per MCFG
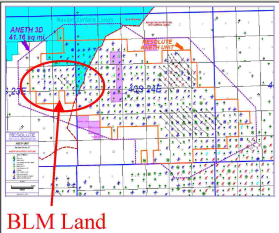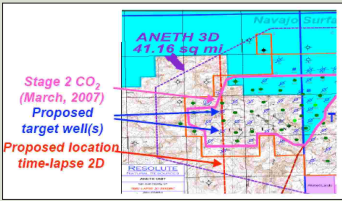- CO_2 Concentration – 97% Pure at McElmo Dome,

McElmo Creek Unit CO_2 Flood Program Water Alternating with Gas (WAG)
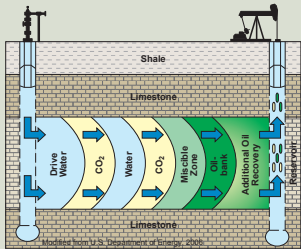
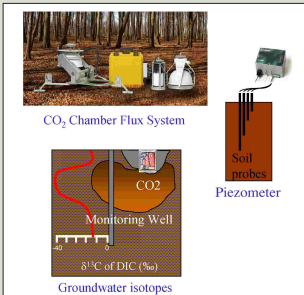## McElmo Creek Unit Oil Production History and CO_2 and Water Injection

Aneth Unit Demonstration Site

BLM Land

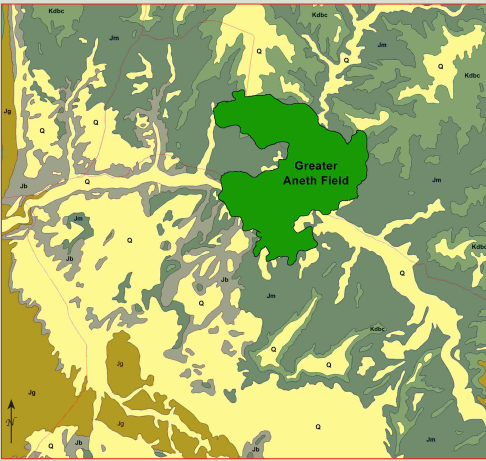## MMV (Monitoring, Mitigation, Verification)

Overview

- Critically Assess CO_2 Impact to Aneth Reservoirs
    - Verify/Predict; CO_2 Placement and Movement in Reservoir
    - Impact to Reservoir (Reactivity, Fracturing)
    - Monitor Any CO_2 Leakage from Reservoir
- Create Most Economic MMV Tool Set to Carry Out Tailored Approach to Reservoir Type

CO_2 Chamber Flux System

Soil Probes / Piezometer

CO_2 Monitoring Well

$\delta^{13}C$ of DIC (‰)

Groundwater isotopes

MMV Tools – Field Experiments (CO_2 Placement-Movement)

- **Imaging CO_2 Placement and Movement – Indirect Methods**
    - Time-lapse 2-D Seismic Reflection
    - Variations on Vertical Seismic Profiles (VSP)
    - Passive Seismic Monitoring
    - Active Doublet Methods
    - Semi-3-D Reflection Survey (aka "Poor Man's 3-D")
    - *In Situ* Pressure, Temperature, Bicarbonate
    - Coupled Models to Measurements

- **Direct Measurements of Movement:**
    - Groundwater: Trace Element, Major/Minor Ions, pH, Alkalinity, Isotopes, Inert Tracers (He, SF6, CFC's, Ar)
    - CO_2 "Piezometers": Sub-Biotic Flux
    - Surface CO_2 Flux: Chamber Measurements
    - Remote Sensing/Landsat Measurements
    - Coupled Process Reservoir Modeling

- **Site Constraints**
    - Land Ownership – Farmers
    - Permitting – Multi-Agency Federal Land
    - Access – Roads, Infrastructure
    - Geology – Complex Terrain

Specific Experiments: Aneth (2006-2009)

- **Background Monitoring (May 2006)**
    - 3-D Seismic, "Poor Man's" 3-D, VSP, Active Doublets, Passive Seismic Modeling (September 2006)
    - Ground and Produced Water Chemical Analysis, CO_2 Chamber Flux, Produced Gas Analysis, Remote Sensing (Beginning May 2006 and then Quarterly)
    - CO_2 Piezometers, Pressure-Temperature-Bicarbonate Measurements (Ongoing)

- **Injection (September 2006)**
    - 150,000 t/yr for 3.5 yrs (April 2007)
    - Ground and Produced Water Chemical Analysis, CO_2 Chamber Flux, Produced Gas Analysis, Passive Seismic Modeling (Quarterly)

Greater Aneth Field

EXPLANATION OF GEOLOGIC UNITS

Q	Quaternary
Kdbc	undivided / Cretaceous
Jm	Dakota Sandstone/
Jb	Burro Canyon Formation
Jg	

Identification of Potential CO_2 Surface Leakage Points - Fractures and Faults

McElmo Creek Unit - CO_2 Injection Well

McElmo Creek Unit - CO_2 Pipeline

MMV Tools – Field Experiments (Experimental Design)

- Observation Well: Geophones and Piezometer
- Water Wells: Transect Away from Injector Well (idea of flow path – tracer)
- Flux Stations: Transect Away from Injector Well
- Surface Seismic: Grid Above Injector Well
- Piezometers: Transects in Soil from Injector Well